OHLF OPEN HYBRID LABFACTORY
Der LeichtbauCampus.

LeichtbauCampus Open Hybrid LabFactory

testXpo 2017

Fachmesse für Prüftechnik

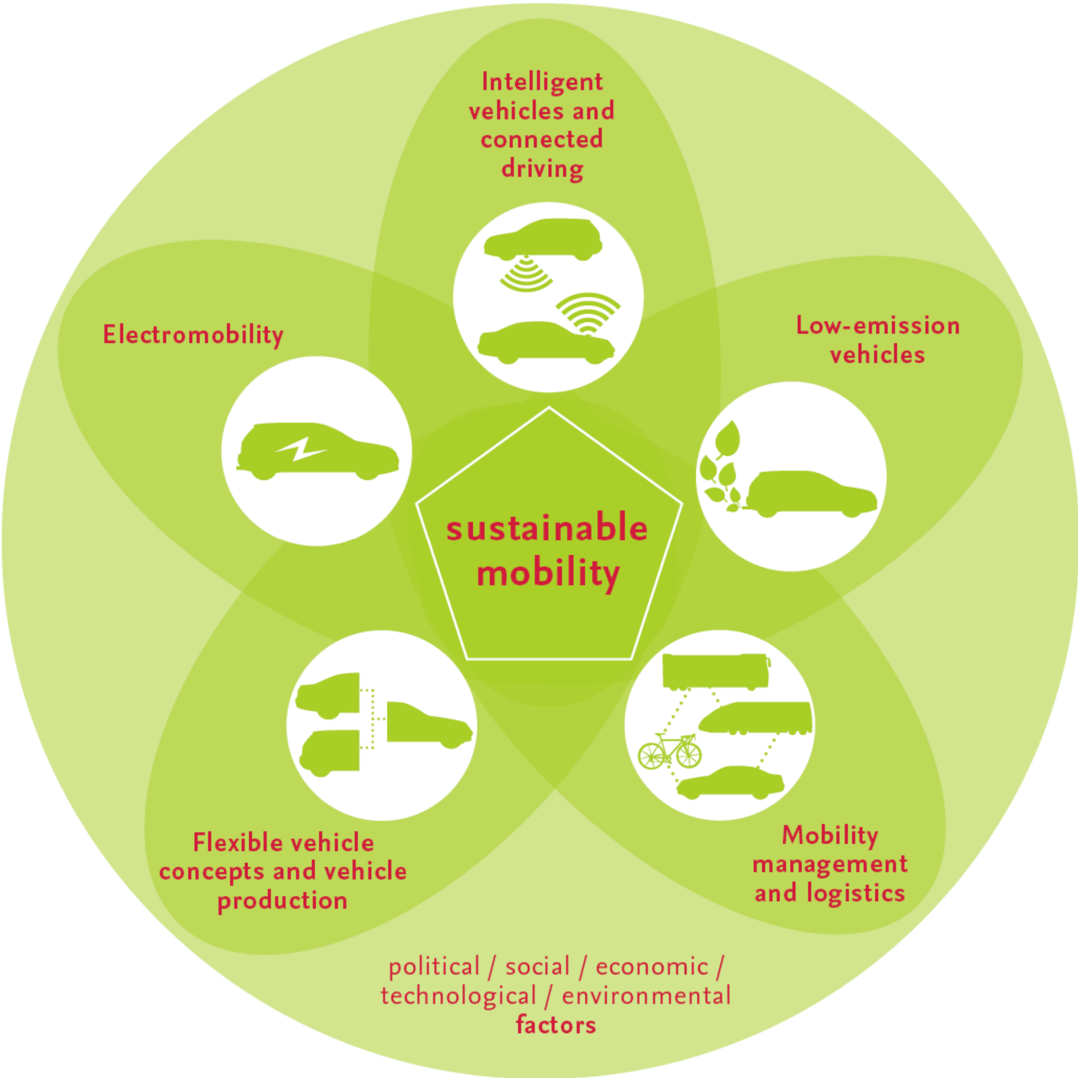
Zwick GmbH & Co. KG

Technische Universität Braunschweig

NIEDERSÄCHSISCHES FORSCHUNGSZENTRUM FAHRZEUGTECHNIK

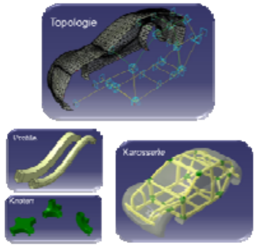
Automotive Research Centre Niedersachsen – Niedersächsisches Forschungszentrum Fahrzeugtechnik

NFF Fields of Research



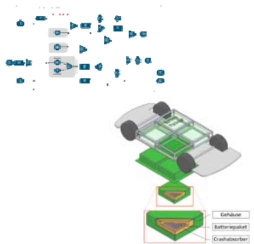
Flexible Vehicle Concepts and Vehicle Production

Vehicle Architectures



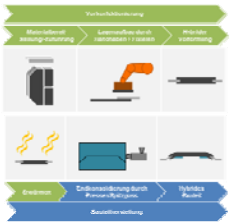
- Modular, flexible, customizable and lightweight vehicle structures
- Package, comfort, safety and economic efficiency
- New production concepts

Integration of Functions



- New approaches to integration
- Integration of sensors, actuators in automotive components
- Weight reduction
- Conservation of resources

Production and Process Engineering



- Production of hybrid components
- Flexible and economical process chains
- Process and automation technology for battery production

Life Cycle Engineering, Production Management

- Methods and tools
- Economy & ecology
- Life Cycle Lab
- Logistics concepts
- Recycling

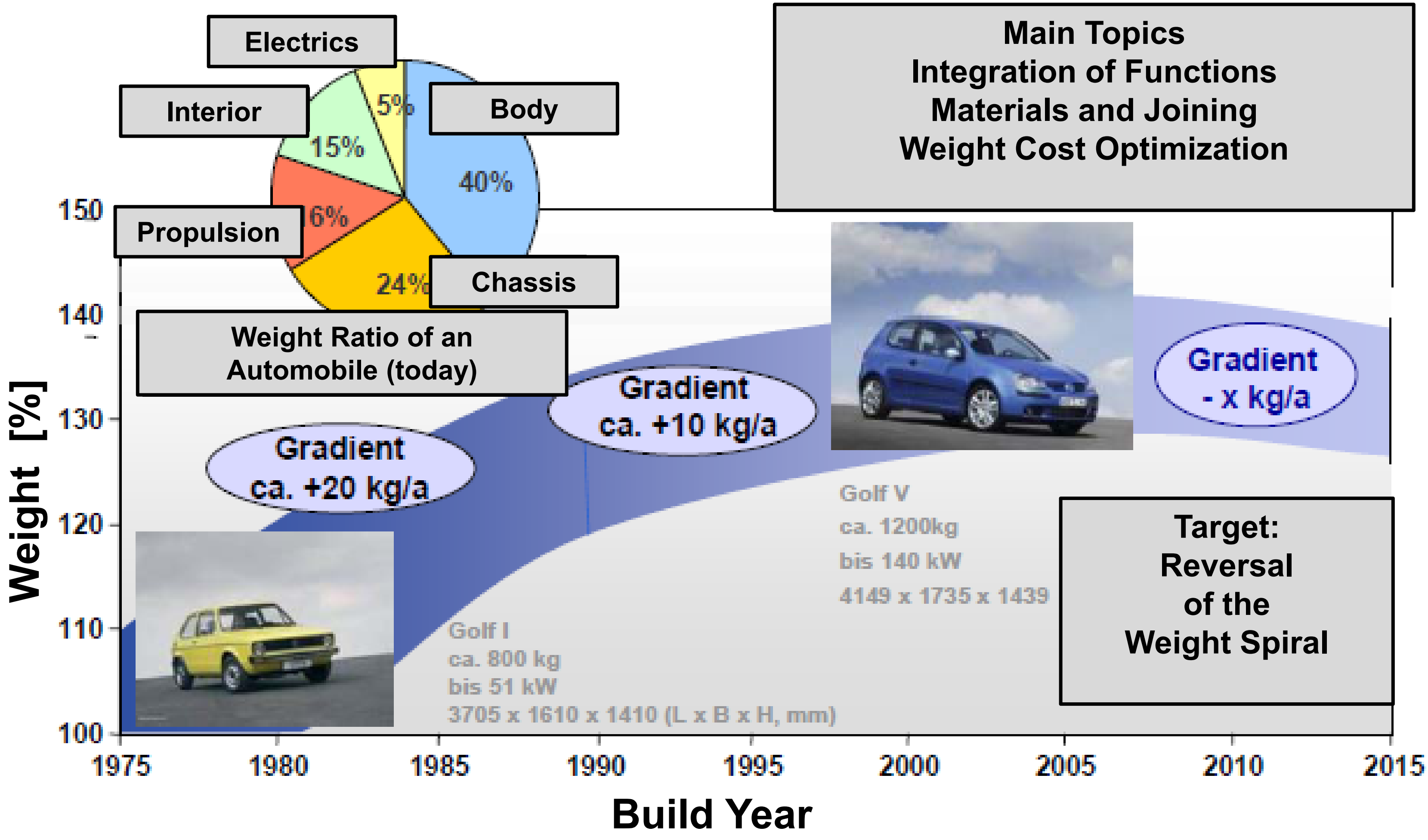
Research Factory - Open Hybrid LabFactory

- Hybrid lightweight components suitable for mass production
- Design of hybrid components
- Sustainable fiber production
- Production process, recycling

Research Factory - Battery LabFactory BS

- Production of battery cells and systems; diagnosis
- Modeling & simulation
- Material production, conditioning, recycling

Actual Situation!



Source: Volkswagen AG

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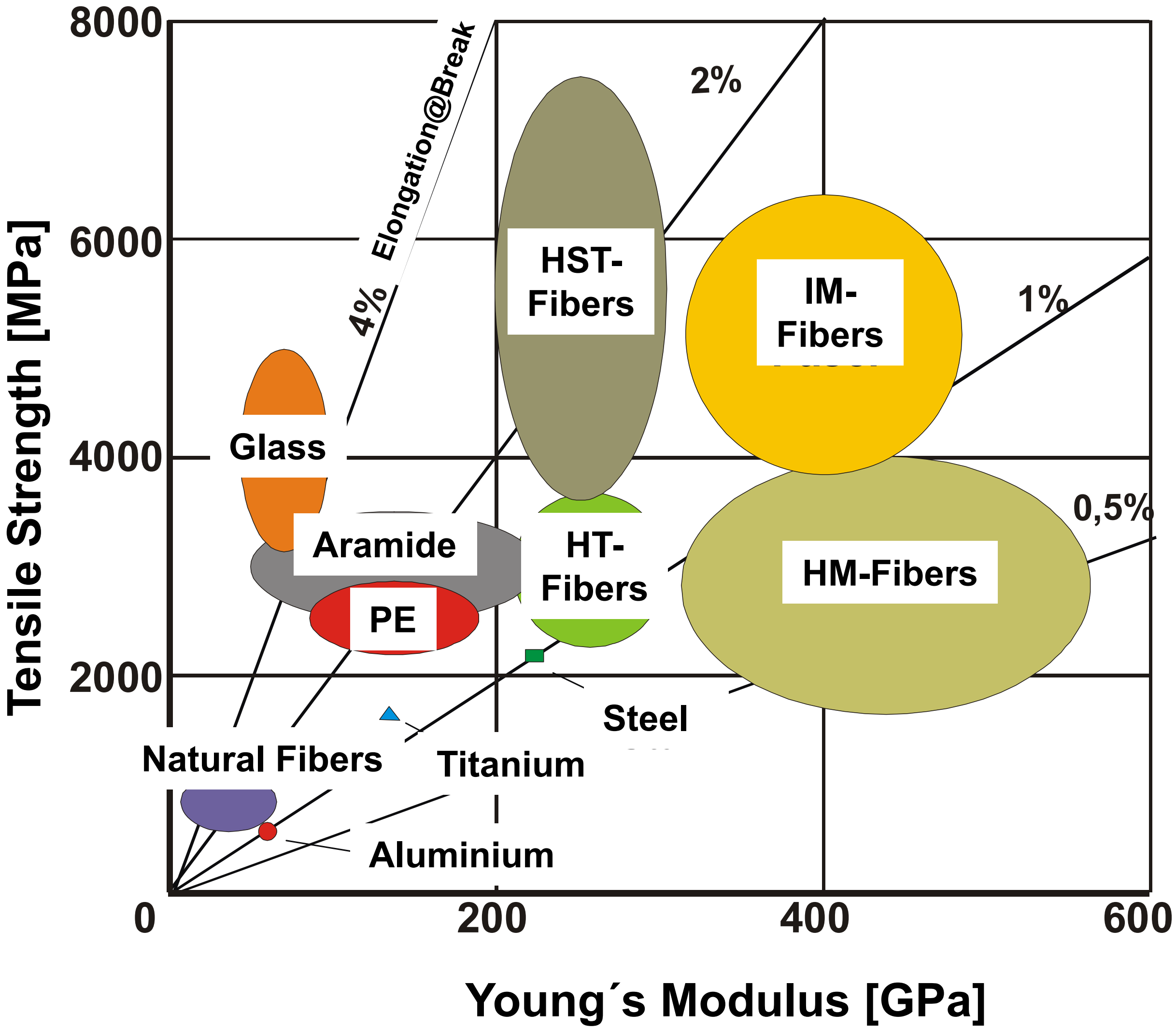
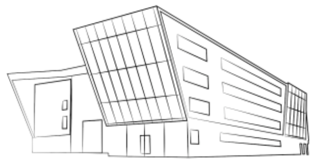
New Materials!



Source: Skript WT II

…Cost Efficency?

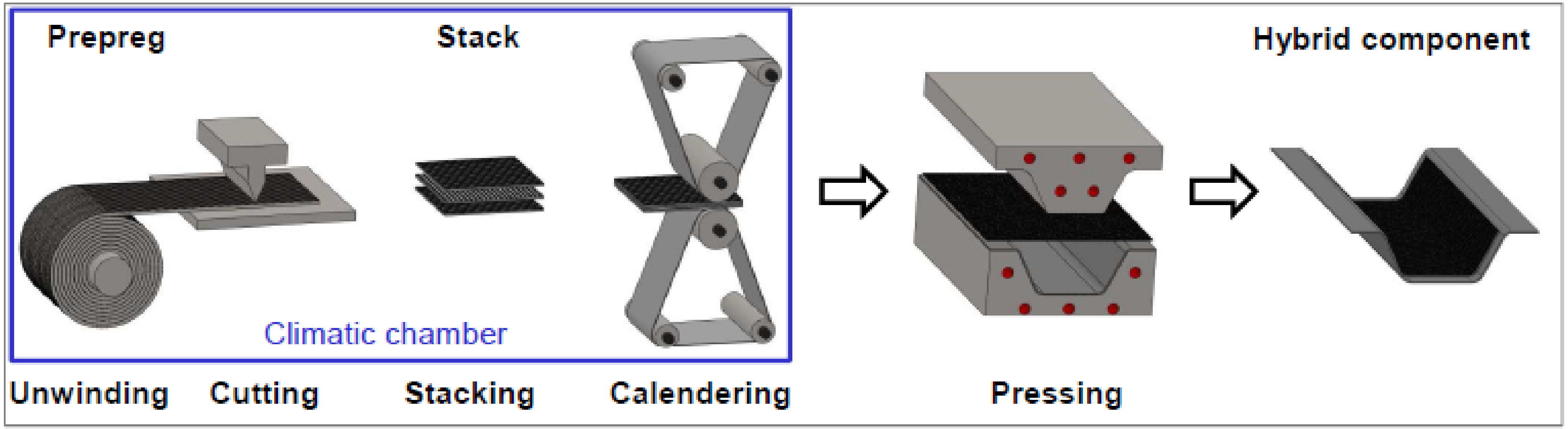
Source: Volkswagen AG



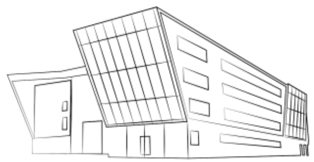
Production Process!

Source: BMW AG

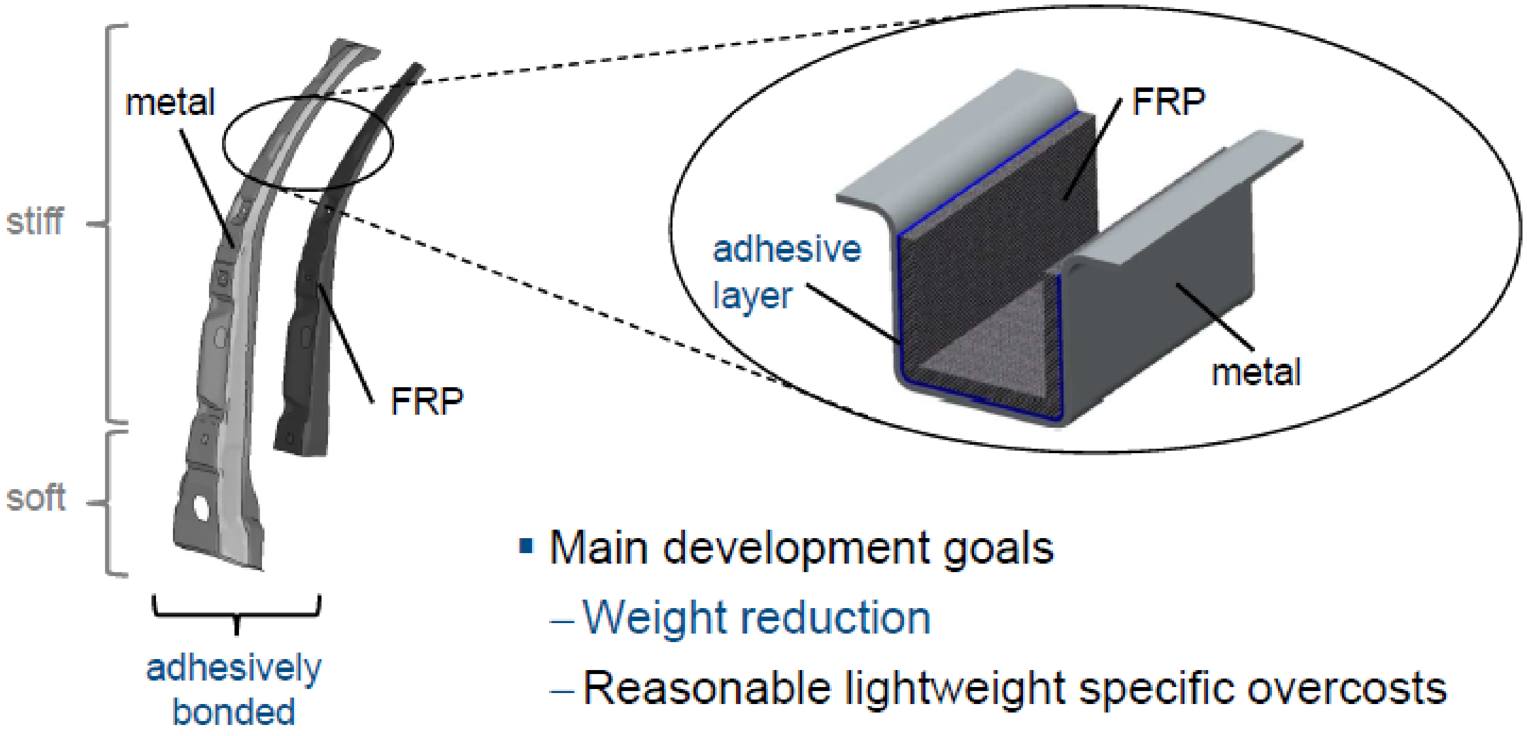
Solution: Hybrid Components!



Source: K.-H. Sauerland, Bad Nauheim 2014



Technologies?



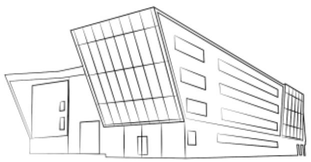
- Main development goals
  - Weight reduction
  - Reasonable lightweight specific overcosts
  - Standardized OEM process chains (e.g. e-coat)

Source: K.-H. Sauerland, Bad Nauheim 2014

Benefits!

- **GFRP** project
  - Weight saving per reinforcement: ~55%
  - Lightweight specific overcosts: ~ 8€/kg
- **CFRP** project
  - Weight saving per reinforcement: ~55-60%
  - Lightweight specific overcosts: ~ 25-30€/kg

Source: K.-H. Sauerland, Bad Nauheim 2014



40 % Weight Reduction, 20 % Cost Reduction!

Source: Malek, Light Weight Design, 01/12

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Hybrid Molding!

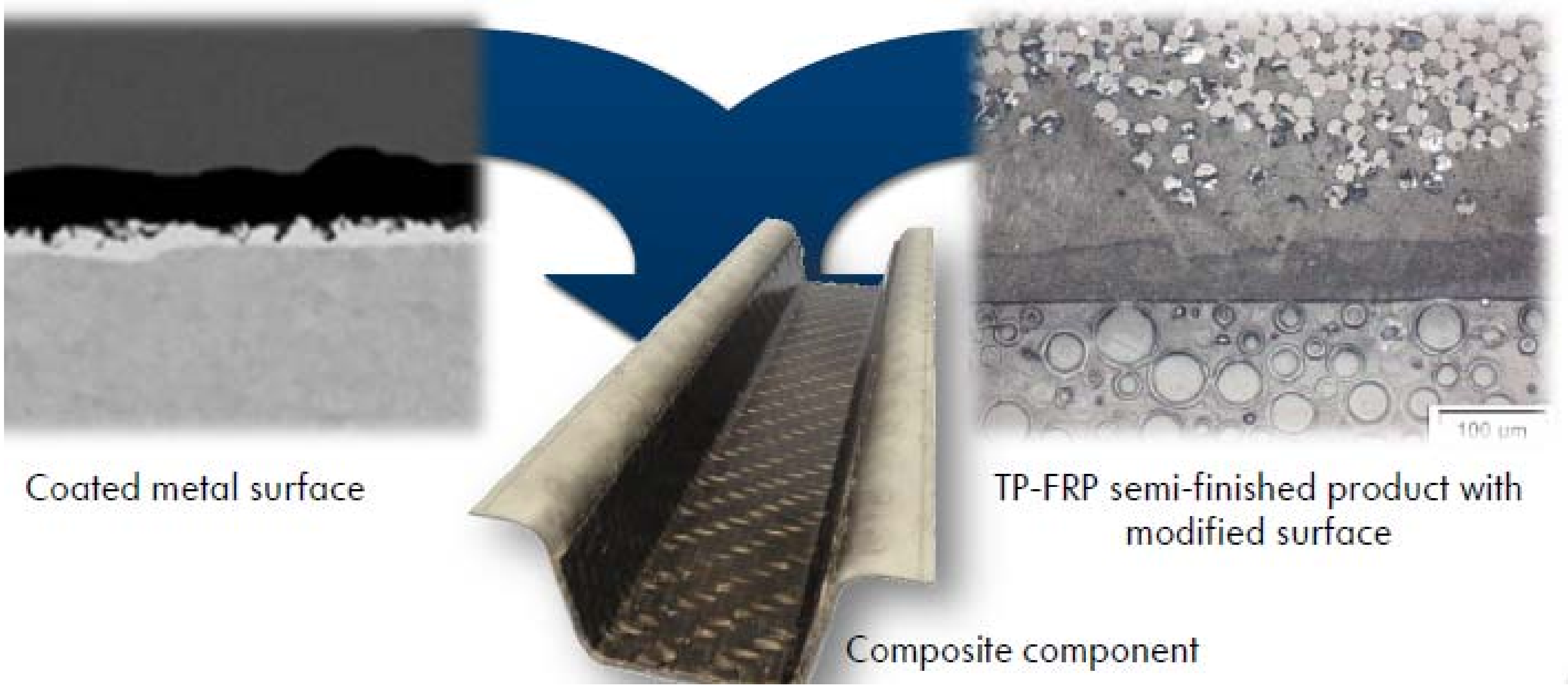
Source: Tower Automotive, Light Weight Design, 09/12

Source: ILK Dresden

Hybrid Metal Design!

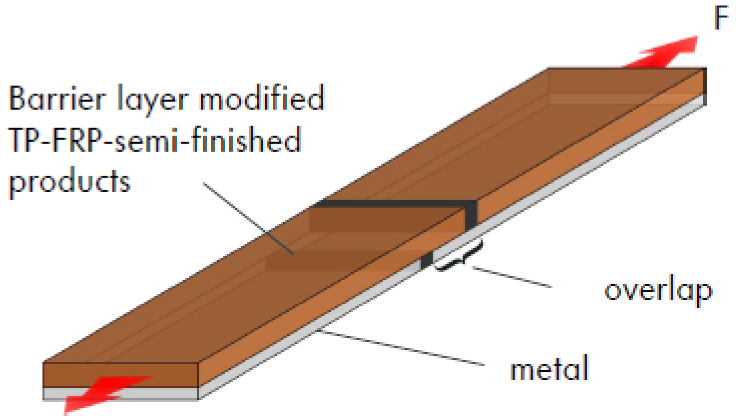
Source: VarioStruct

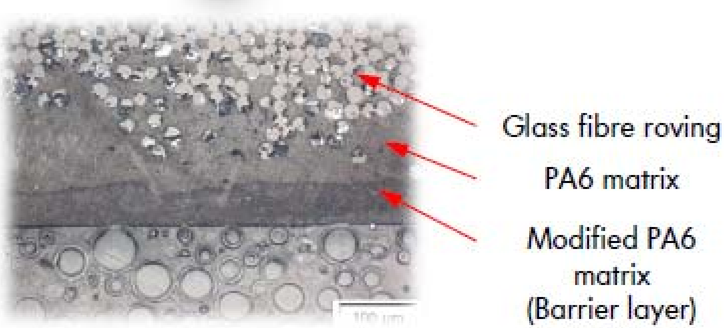
Joining/Interfaces!

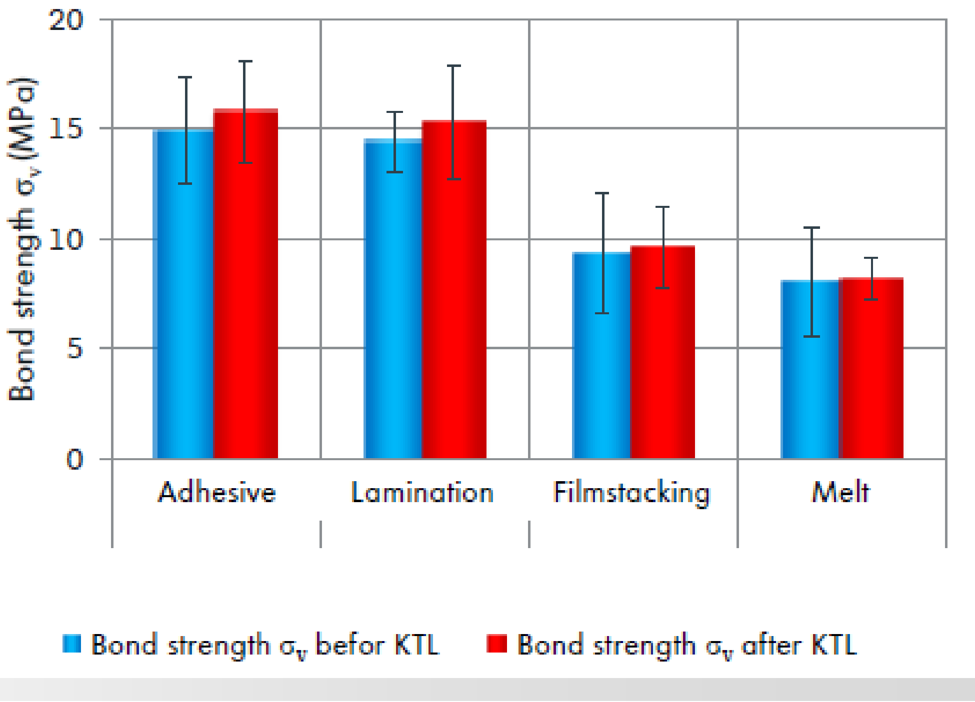


Source: Klemt, Kurz, Becke, Bad Nauheim 2014

Joining/Interfaces!







Source: Klemt, Kurz, Becke, Bad Nauheim 2014

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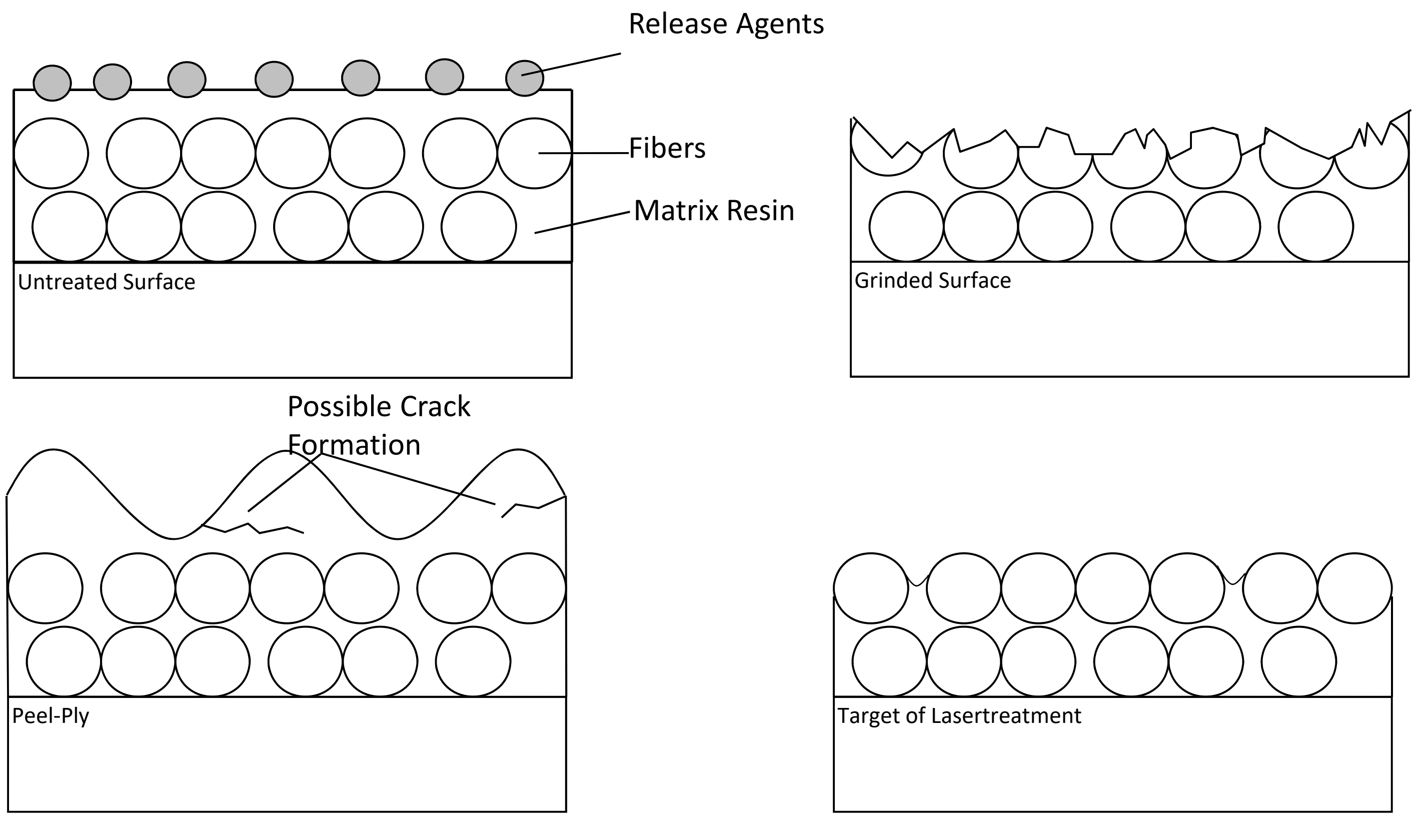
Surface Conditions of FRP



Source: *ifs, TUBS*

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Surface Pretreatment

Challenge:

- Release Agents on the Surface of FRP-Parts

State of the Art:

- Manual Grinding

Disadvantages:

- No Automization
- High Process Costs
- Additional Material
- Drying after Pretreatment (Wet Grinding)
- No Selective Removal

Need for Alternative Pretreatments:

- Good Reproducability
- Possibility of Selective Removal
- No Additional Process Steps

Peel-Ply

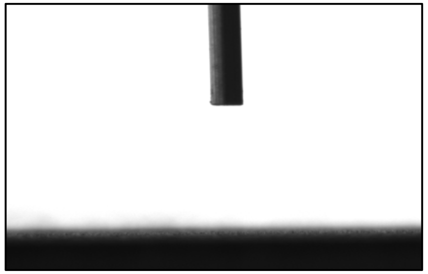
Grinded Surface

Source: *ifs, TUBS*

Wetting

Contact Angle

Energy [kJ/mm²]	Contact Angleθ [°]	
	DC 01	**HX340LAD+Z100MB**
0 (cleaned)	94,1	81,4
3,5	18,5	25,7
11,4	14,1	20,5
22,8	3,3	5,6
67,2	-	-

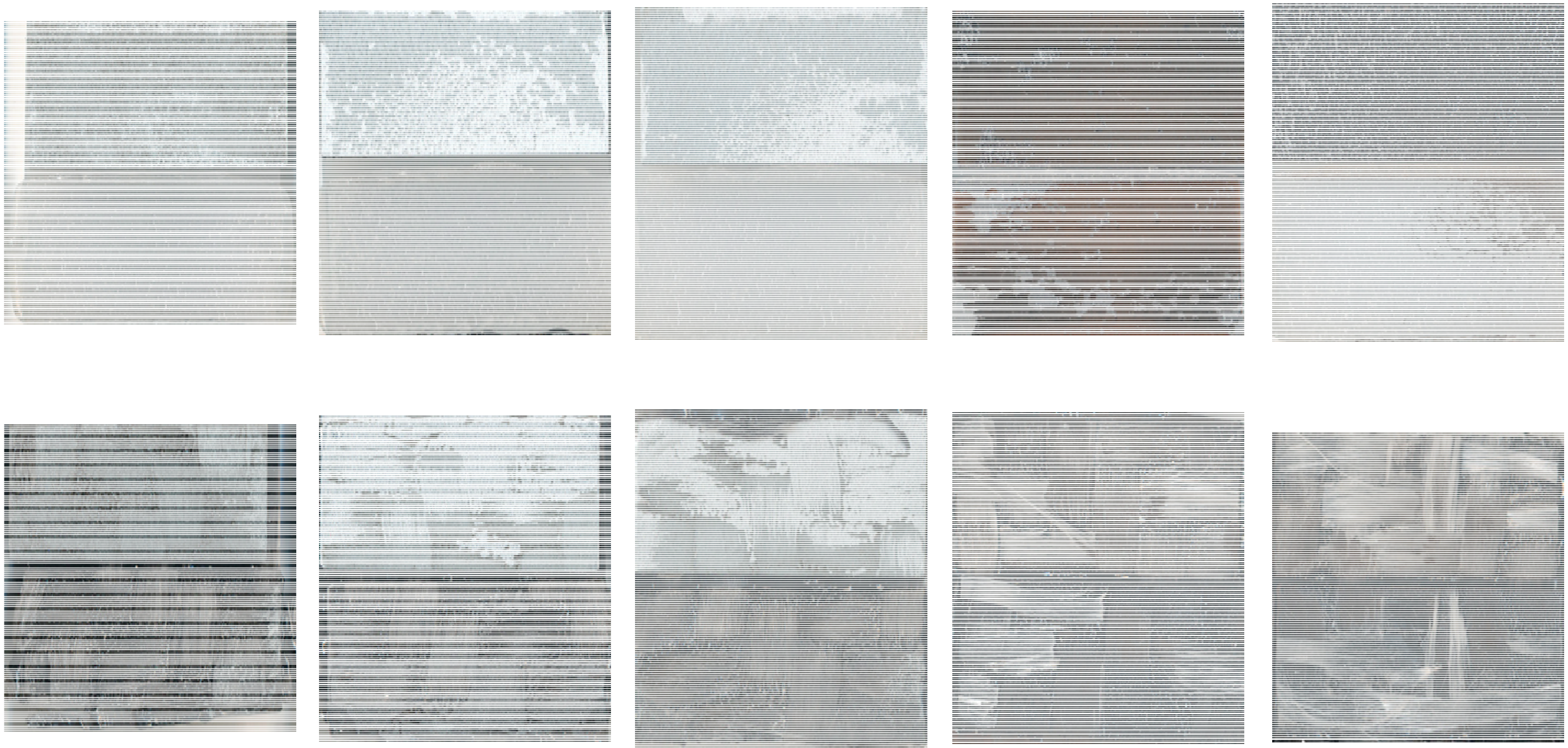
Wetting			
Contact Angle θ	18° … 25°	3° … 6°	0°

Adhesion

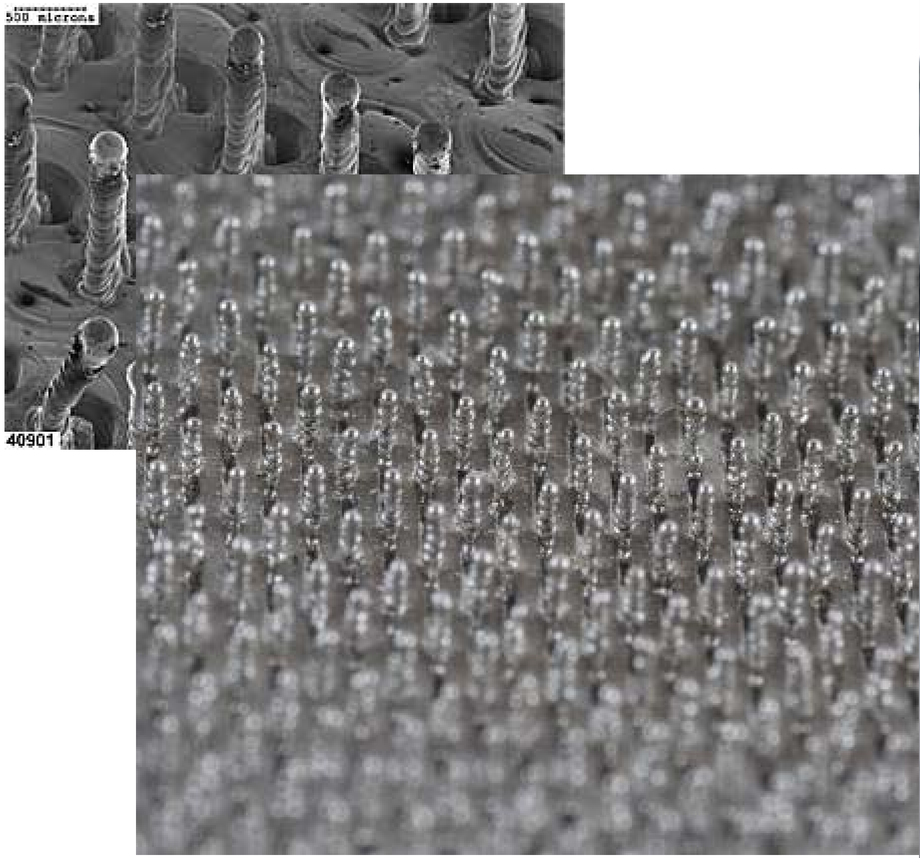
1,4 kJ/mm² | 3,5 kJ/mm² | 11,4 kJ/mm² | 67,2 kJ/mm² | 202,7 kJ/mm²

HX340-PA 6

HX340-PA 6-GF



Alternative Surfaces



Source: TWI, Cambridge

Source: ISF, Aachen

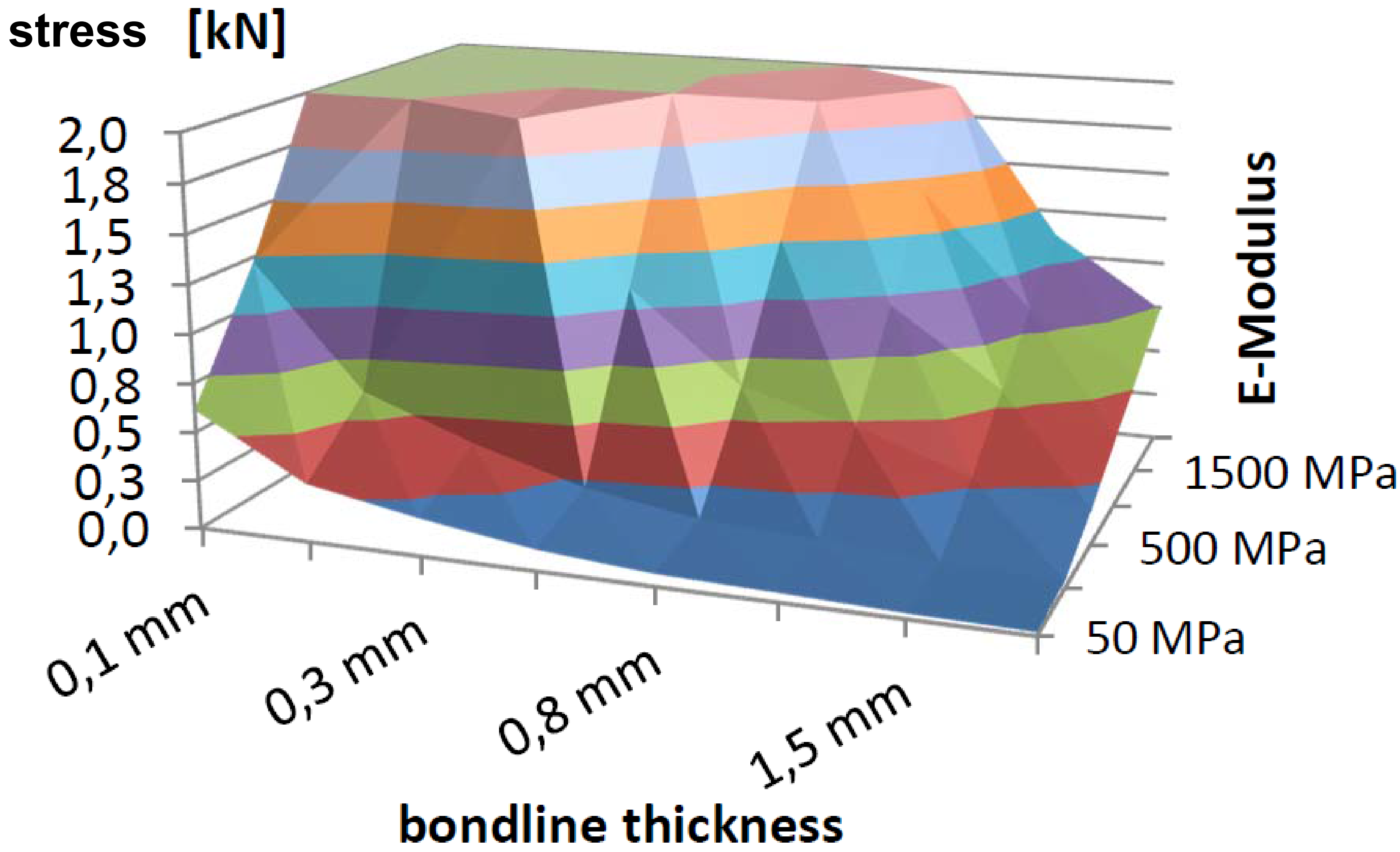
Hybrids / Joining

$\alpha_{CFK} = 0 * 1/K$

$\alpha_{Al} = 23 * 10^{-6}\ 1/K$

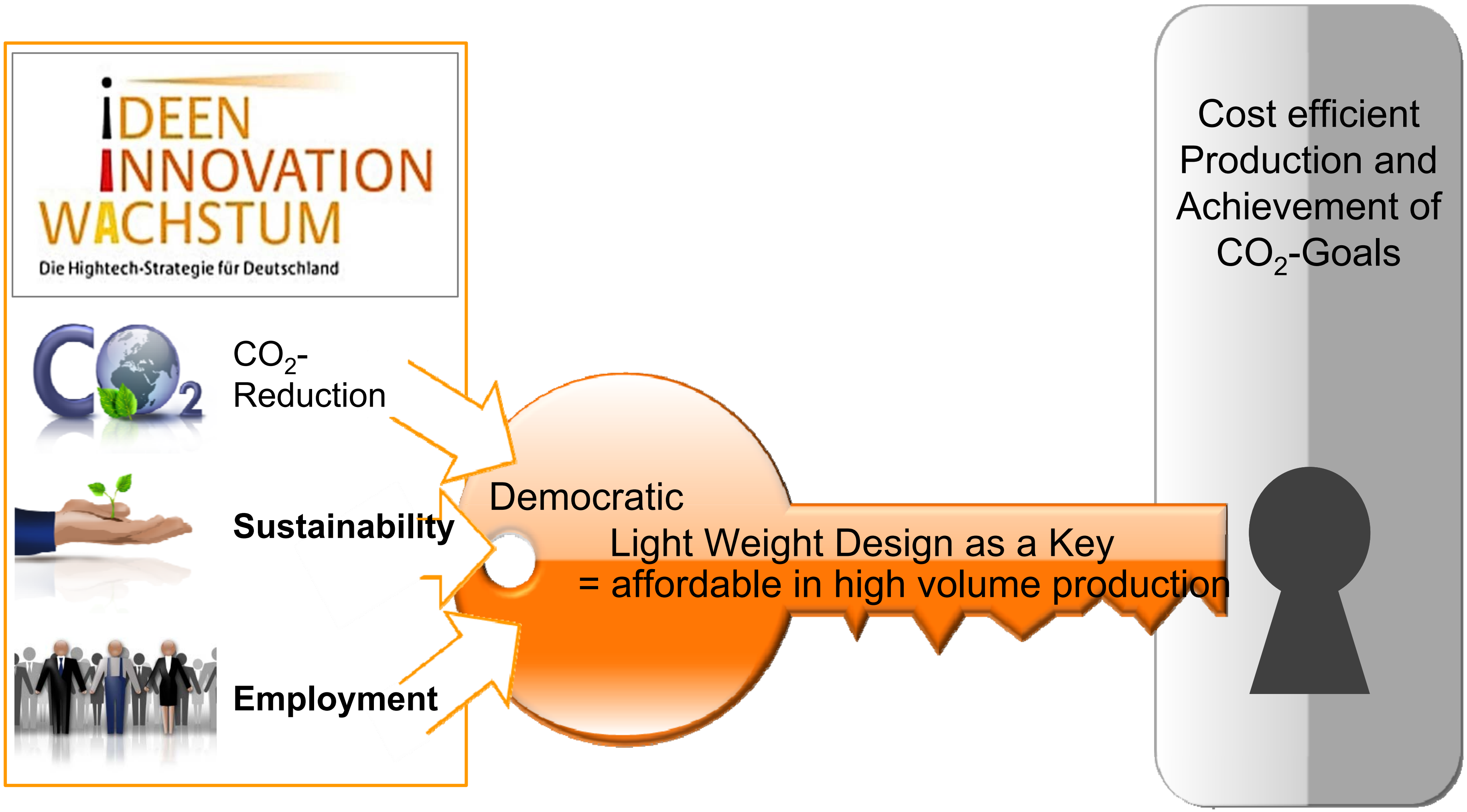
Source: BMW AG

Stresses Due to Thermal Expansion Mismatch



Source: Morley, Schmatloch, Dow, Fügen im Automobilbau, 2015

Light Weight Design



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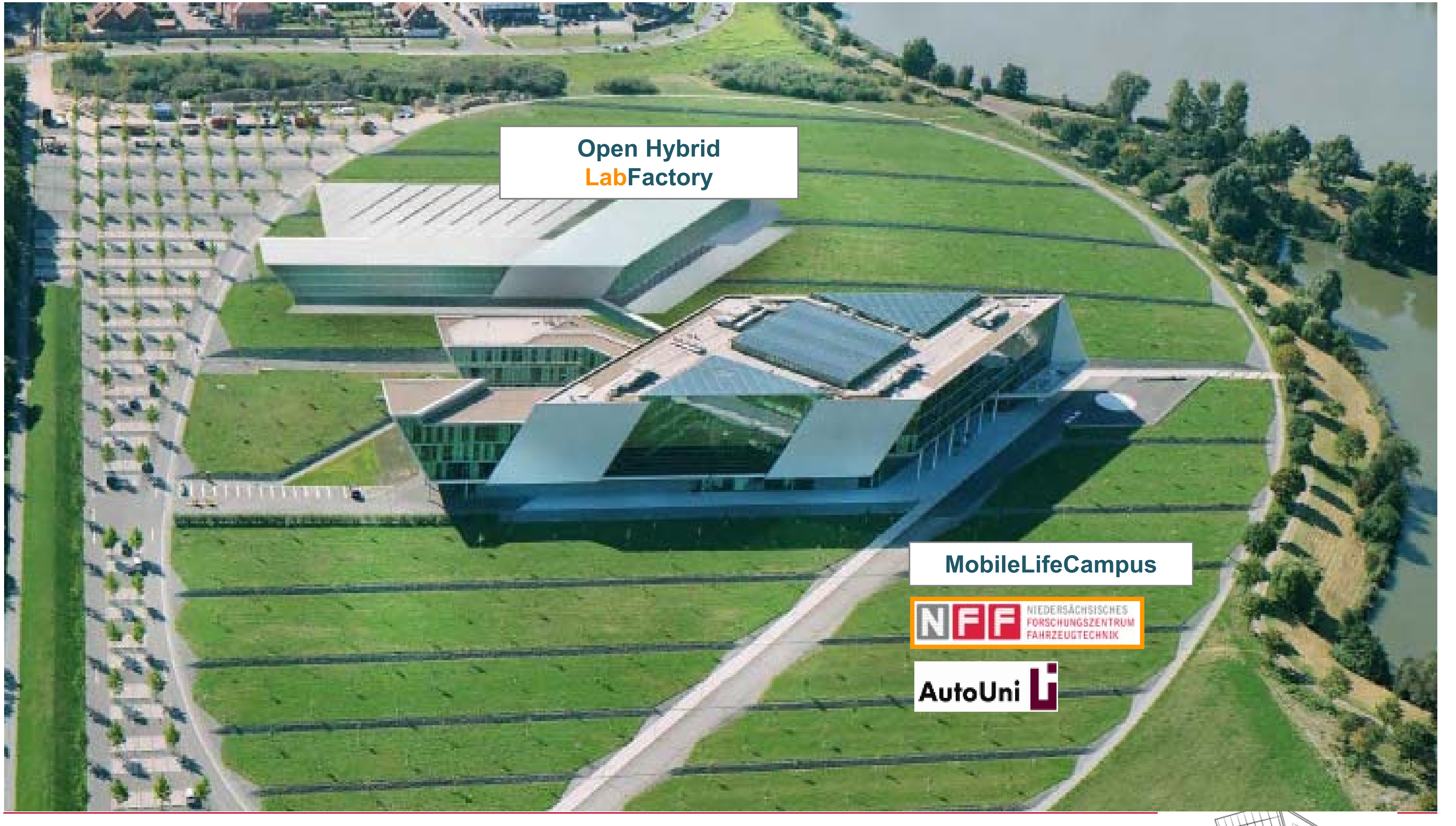
Concept HENN



Open Hybrid LabFactory
Building

Parcel of Land:	10.000 m²
Floor Space:	9.400 m²
Storey height:	14 meters (LabFactory) and meters(Labs)

Open Hybrid LabFactory
Open Hybrid LabFactory

Open	▪ Integration of the expertise of scientific and industrial research in an „open factory“
Hybrid	▪ „Democratized” lightweight construction by the use of hybrid composite structures made of plastics, metal and load-path-optimised textile structures
LabFactory	▪ Establishment of the world' s leading technology companies and top level research along the process chain in Wolfsburg

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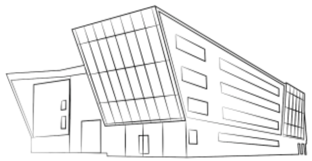

Open Hybrid LabFactory e.V.
Members

12 Premium- und 16 Project Members

Premium Members

Technische Universität Braunschweig / NFF	VOLKSWAGEN AKTIENGESELLSCHAFT	BASF The Chemical Company	DowAksa	ENGEL be the first	WOLFSBURG
Fraunhofer	iav automotive engineering	MAGNA	Siempelkamp	thyssenkrupp	Zwick / Roell

Project Members

Leibniz Universität Hannover / NFP Niedersächsisches Forschungszentrum Produktionstechnik	cetex	DLR Deutsches Zentrum für Luft- und Raumfahrt	data M Sheet Metal Solutions	DREISTERN	EDAG	IFF	ifu hamburg
TU Clausthal / NFM Niedersächsisches Forschungszentrum Materialtechnik	INVENT	iPoint	KARL MAYER	KWD AUTOMOTIVE	LSE	SALZGITTER MANNESMANN FORSCHUNG	SCHMALZ

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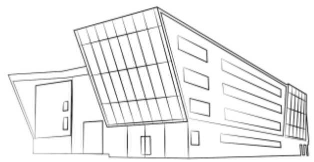

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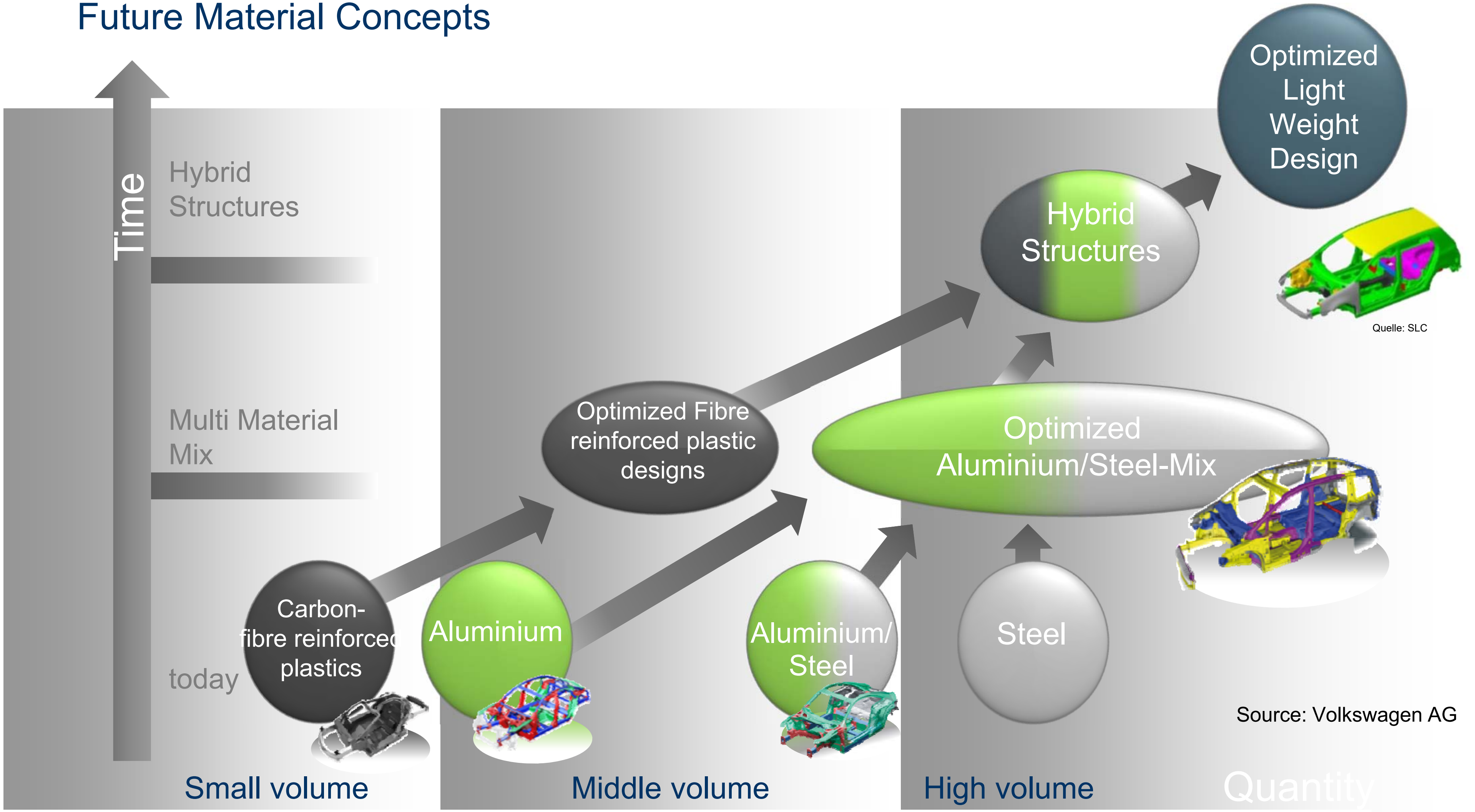
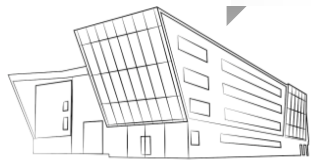
Future Material Concepts





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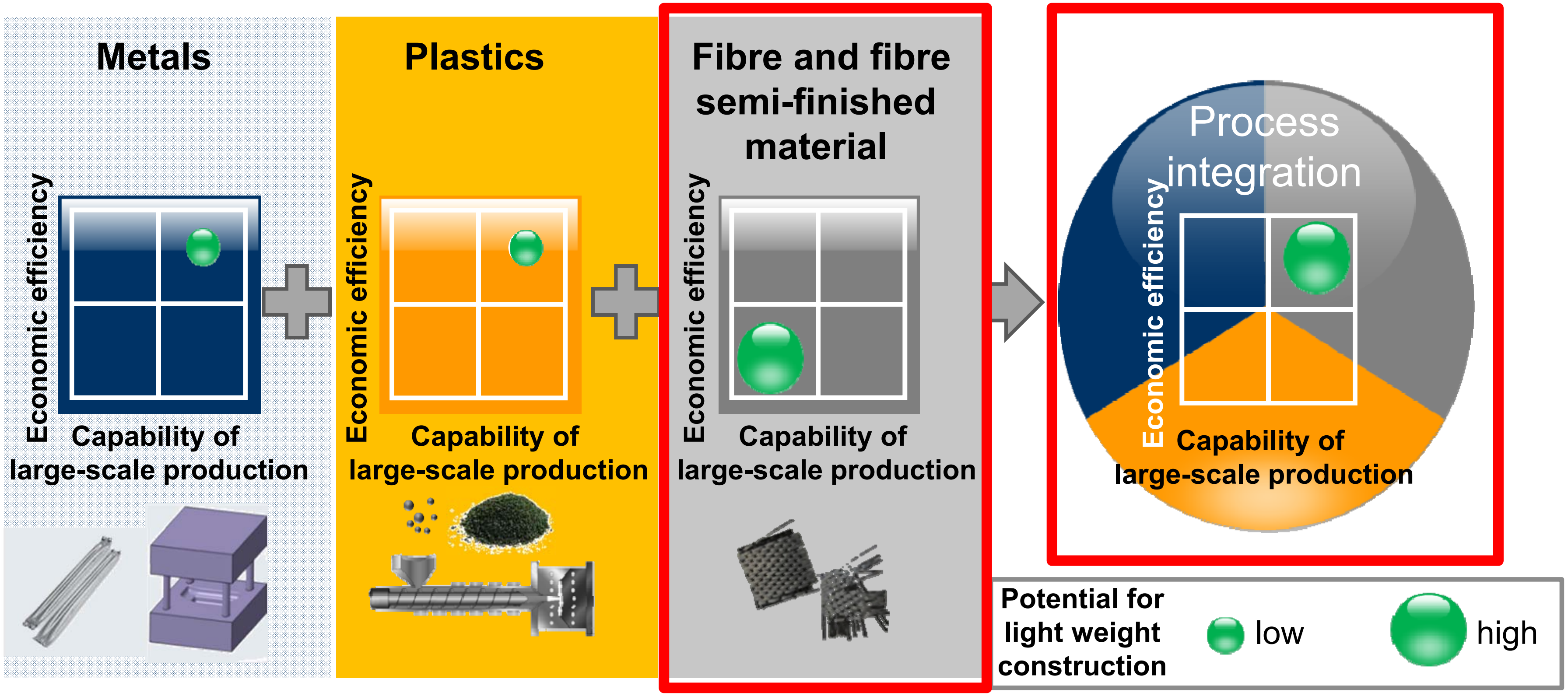
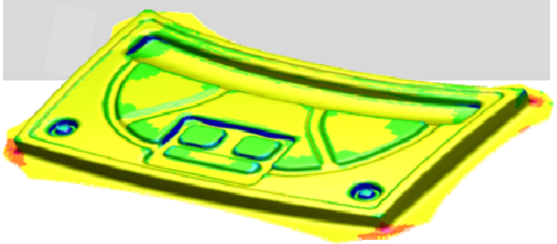
Strategic Approach to a Large-Scale Production

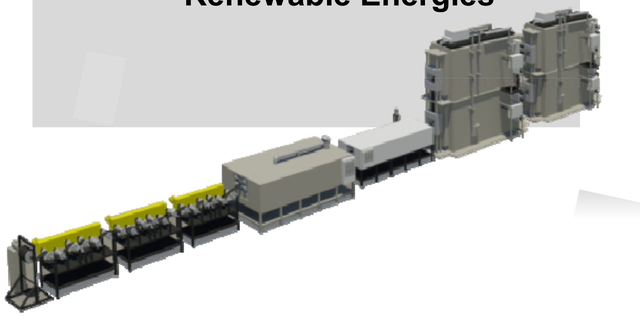


Open Hybrid LabFactory
Research focus

Concept/ Construction/ Simulation	Load-path-optimised Textile Structures	Process Hybridisation
Example: Component and Process Development for Hybrid Lightweight Components	**Example: Sustainable Fibre Production**	**Example: Integrated Production Technologies**
Desgin, Engineering, Construction, Optimization of Hybrid Lightweight Components Component and Process Simulation	Low-cost Automotive C-Fiber in Germany Energy Efficiency Renewable Energies	One Cycle – One Component Suitable for Large-Scale Production Process-Compatible



Volkswagen AG



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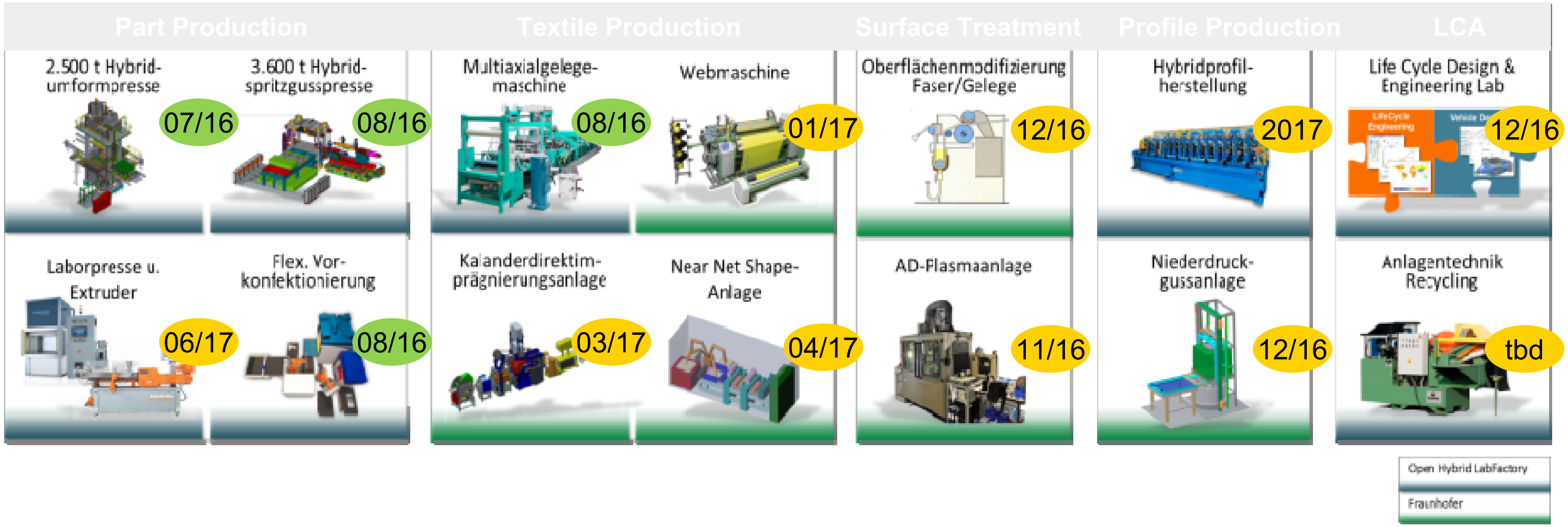
Facilities of OHLF



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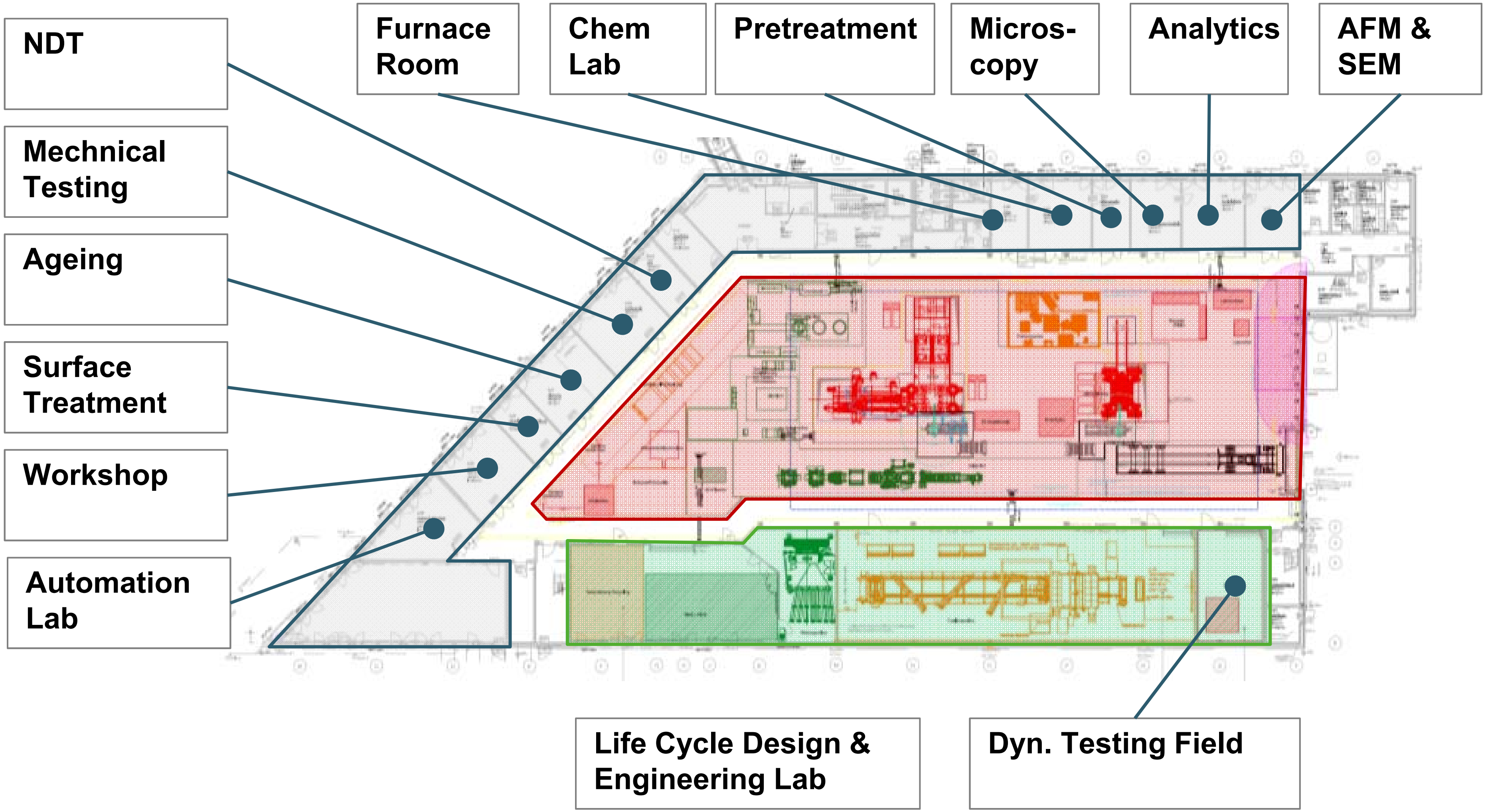
Research Labs



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Roadmap for quality assurance and test methodology

Phase I 2013 - 2017	Phase II 2018 - 2022	Vision 2030
▪ Development of methods for mechanical testing of hybrid structures ▪ Determination of material properties for simulation issues ▪ Determination of detection boundaries of non-destructive testing methods for composite materials ▪ Evaluation of basic correlations between process parameters and properties of hybrid structures	▪ Evaluation of the effects of defects on material properties ▪ Customized processes for quality assurance based on mechanical and non-destructive testing ▪ Development of testing methods for adaptive manufacturing processes	▪ Large scale production of high quality structures based on… … a basic understanding of the mechanical properties of hybrid materials … a fundamental knowledge of the influence of loading conditions as well as physical and chemical interactions … tailored non-destructive testing methods … the effect of defects

Standardization

- Definition of testing standards for mechanical and non-destructive testing of hybrid structures
- Qualification of manufacturing processes

Simulation

- Damage modelling under static, cyclic and dynamic loading
- Determination of effects of defects
- Modelling of adhesion phenomena

Interfaces

- Methods for characterisation of surfaces
- Basic understanding of chemical and physical interactions
- Application of test methods within the production processes

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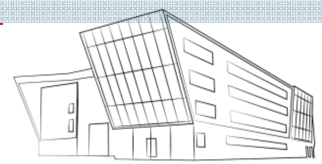


Example: Roll forming of hybrid materials

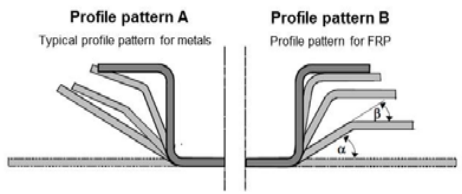
Material supply
- Steel (Primer)
- CF-PA 6 Tape

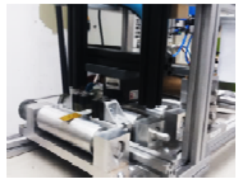
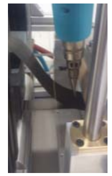
Forming
Manufacturing steel profile

Joining
Heating CFR-TP and steel

Finishing
- Straightening
- Cutting



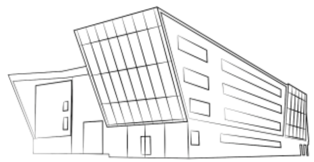




Process influences:
- Climatic conditions (temperature, humidity)
- Materials (moisture content PA 6, etc.)
- Process (processing speed, pressure, etc.)
- Heating (induction and IR-parameter)
- Forming stations (number, etc.)

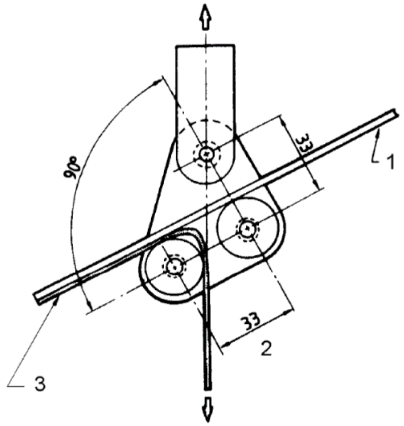
Process control:
- Recording process parameters (temperature, pressure, etc.)
- Temperature regulation (pyrometer)
- Optical testing
  - Voids etc.
- Geometry measurement

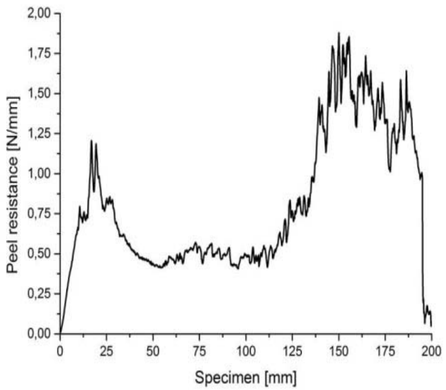
Sources: Friedrich, Henninger, Reincke

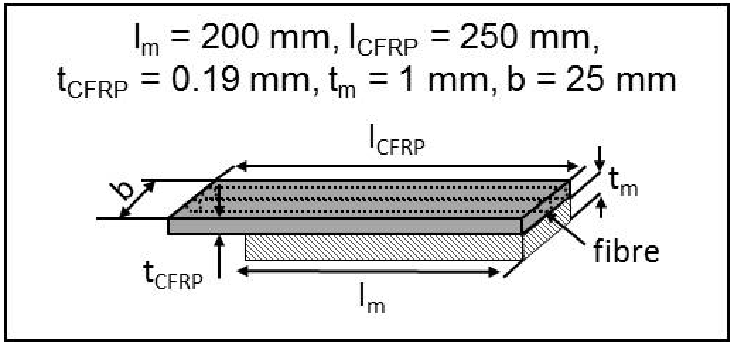


Characterisation of mechanical properties of interfaces I/II

- Floating roller peel test derived from DIN EN 1464
- Evaluation of adhesion between steel and CFR-TP
- Testing of continuously manufactured hybrid specimens
- Rigid adherend consisting of steel
- Flexible adherend consisting of CFR-TP
- Suitable for peel resistances up to 1.2 N/mm







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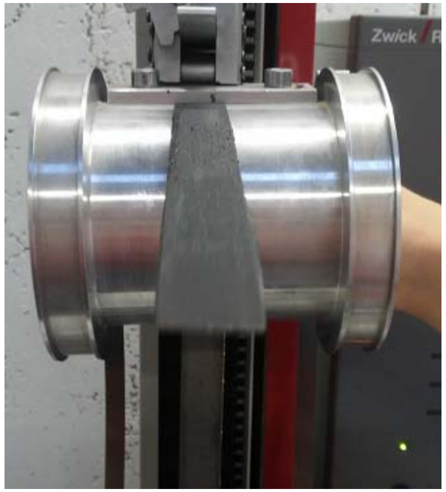
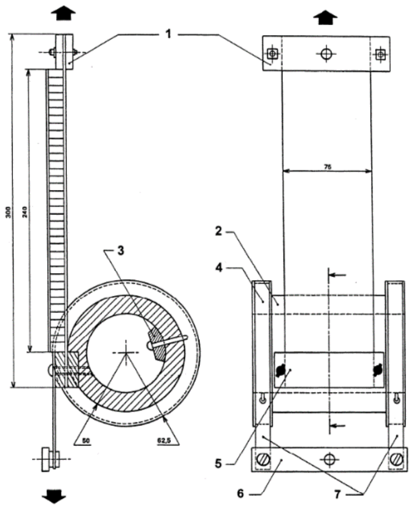
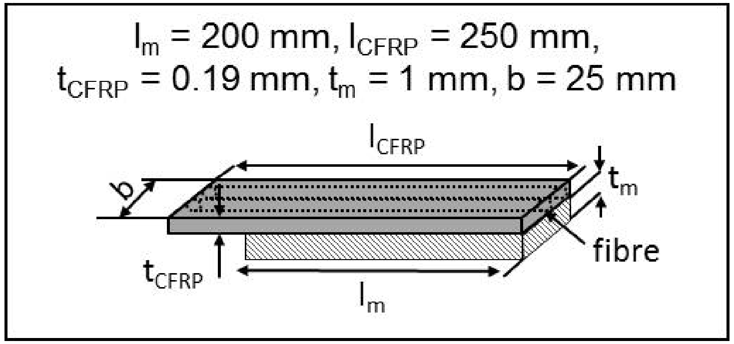
Characterisation of mechanical properties of interfaces I/II

- Climbing drum peel test derived from DIN EN 2243-3
- Evaluation of adhesion between steel and CFR-TP
- Testing of continuously manufactured hybrid specimens
- Rigid adherend consisting of steel
- Flexible adherend consisting of CFR-TP
- Suitable for peel resistances up to 16 N/mm





Source: DIN EN 2243-3



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Many thanks for your attention!